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Description

Method for changing the image size of video images

Such changes in image size are required, in particular, for picture-in-picture (PiP) insertions, in the case of which a small image is faded into a main image. The image size of the small image is reduced for this purpose in proportion to the main image. For a known image reduction, reduction in a horizontal direction and in a vertical direction correspond to one another in this case, resulting in total reduction factors which correspond to reciprocal squares such as 1/4, 1/9, 1/16, 1/36. The image signals thus reduced are read into an image memory together with the image signals of the main image for the purpose of synchronization, in which the pixels and lines occurring over the duration of a small image line or of the entire small image are stored, in order to achieve the change in image size.

A finer change in the horizontal reduction factor is possible, for example, by changing the read-out frequency of the image memory. A corresponding change in the vertical reduction factor is, however, not possible since the vertical frequency is fixed by the TV standard.

The invention is based on the object of achieving better possibilities for adjusting the image reduction in conjunction with a relatively low outlay and high image quality.

This object is achieved by means of a method according to claim 1. The subclaims describe preferred developments of the method according to the invention.

A large range of decimation factors can therefore be achieved by combining the integral decimation with a fine decimation, with the aid of which non-integral values can be registered, before the buffering in the image memory. A total decimation can

be achieved as a product of two individual decimations, since the latter are carried out consecutively.

In particular, a continuous or quasi-continuous numerical range such as, for example, from 1 to 1.5 can be adopted for the fine decimation. It can be bounded in a sensible way by combination with the integral decimation, since a larger range of non-integral values can be covered by multiplying non-integral values with integral values. For this purpose, a range for the total decimation factor which comprises several integral values can be covered, in particular, by appropriately tuning the adjustable integral decimation factors and fine decimation factors to one another without this range having gaps of values which cannot be adjusted.

An appropriate decimation filter is generally used in the decimation of several image signals to form an image signal for which the single value is formed from several values. It is possible to make use for this purpose in particular of a decimation filter with a low-pass effect which therefore has an integrating effect and suppresses noise. This low-pass effect can advantageously be used for noise suppression of the output signals of the fine decimation by following the fine decimation with the integral decimation. Furthermore, an additional low-pass filtering can also be carried out before the two decimations; the flattening of the signals effected by the low-pass filter or low-pass filters can be compensated by subsequent frequency response crispening.

The fine decimation by non-integral values can advantageously be achieved in this case by linear interpolation of video image signals.

The decimation according to the invention can be used in this case both for the horizontal and for the vertical decimation of the video image signals. In particular, it is possible thereby to create a method

for fine-step or stepless changing of image size, in the case of which the variation in the horizontal and vertical directions can be undertaken independently of one another in fine steps.

The invention is explained in more detail below with the aid of the attached drawings and with reference to a few embodiments. In the drawing:

Figure 1 shows a block diagram of a method according to the invention for horizontal and vertical changing of image size;

Figure 2 shows a block diagram of a method according to the invention for horizontal changing of image size;

Figures 3 a, b show timing diagrams of video image signals for the purpose of explaining the fine decimation of image signals according to the invention;

Figure 4 shows a block diagram of a method according to the invention for vertical changing of image size.

The method according to the invention can be used in principle for changing image size in the vertical and/or horizontal directions.

In the case of a method for stepless or fine-step changing of image size in both directions in accordance with Figure 1, a video signal V of a small image to be reduced is subjected consecutively to horizontal and vertical decimation and subsequently read into an image memory 5 as a horizontally and vertically decimated video image signal V^*, in which memory it is stored together with a main image such that the superimposed video image can subsequently be read out of the image memory 5.

The video signal V passes for this purpose consecutively into a horizontal scaler 1 for horizontal fine decimation, a horizontal decimation filter 2 for integral horizontal decimation and low-pass filtering, a vertical scaler 3 for vertical fine decimation, and a vertical decimation filter 4 for integral vertical decimation and low-pass filtering. Control signals SHS,

MHD, SVS, MVD are input by a control device 6 into the respective scalers 1, 3 and in decimation filters 2, 4.

The horizontal decimation is performed in this case before the vertical decimation, since this reduces the outlay on storage for the line delays required in the vertical decimation by the amount of the horizontal reduction.

The horizontal decimation filter 2 effects sub-sampling by an integral decimation factor MHD. For this purpose, it is possible in principle to use a known decimation filter, such as, for example, a decimation filter with a low-pass effect. It is possible with such decimation filters also to make use, in particular, of the noise-suppressing and integrating effect of the low-pass filters. It is possible, however, to use an MTA core filter which permits a filter characteristic to be adapted to various decimation factors.

The horizontal scaler 1 permits fine-step or stepless decimation of the incoming video signal V of the small image by the fine decimation factor SHS. This fine-scaling therefore also requires, if appropriate, decimation by non-integral fine decimation factors SHS. For this purpose, the horizontal scaler 1 has an interpolation filter which operates in a time-variable fashion and calculates the samples required for fine-scaling. The scaler carries out the conversion necessary for converting the sampling rate from an initial sampling rate LHS to a sampling rate MHS, for example as oversampling by the factor LHS, filtering and sub-sampling by the factor MHS. For the case in which LHS<MHS, the desired reduction in the number of pixels is undertaken by reducing the sampling rate. The number of pixels and the sampling rate are increased for LHS>MHS. It is possible to keep LHS fixed in this case, since adjusting the decimation factor suffices for adjusting the reduction factor. The factor SHS can

therefore be formed in accordance with the equation MHS = LHS + SHS. A reduction in the number of pixels therefore results in each case.

An upper bound is selected for the reduction factor, which can be 1.5 or 2, in order to avoid interfering effects in the filtering. In this case, the scaler also permits a delay of less than one sampling period, that is to say MHS/LHS < 1, which can advantageously be used to compensate the raster error in the case of asynchronous sampling rasters. The time diagrams of figure 3 show the known mode of operation of the scaler 1 used for fine decimation. In accordance with figure 3a, a signal is sampled with the time period T. Phase-shifted values can be determined from these values by linear interpolation in accordance with Figure 3b, as is shown here by a period T^*. Starting from a sample and the sample delayed by one period, the interpolator calculates a new sample on the basis of the phase newly calculated for each period. If the phase value exceeds the range of one sampling period, the sample actually to be calculated is firstly omitted, thus achieving fractional rational decimation. Not until the following cycle is a new sample calculated, the phase value being corrected by a simple overflow arithmetic. Such an interpolation is required in this case in the determination of non-integral decimations; if an integral total decimation is selected, this can possibly be achieved directly by MHD by setting the fine decimation factor MHS/LHS = 1. In principle, it is also possible to make use instead of a linear interpolator of any other interpolator of the n-th order for the scaler 1.

Since the decimation filter 2 with integral decimated is connected downstream of the scaler, its low-pass effect can reduce a possibly interfering signal spectrum following a non-ideally interpolating scaler. Furthermore, in accordance with figure 2 a

low-pass filter TP1 is arranged upstream of the scaler 1, in order as the low-pass pre-filter to increase this stop-band attenuation. Steeper signals can be achieved, in turn, by a peaking P, downstream of the decimation filter 2, for the purpose of frequency response crispening. The peaking can be kept adjustable in this case in order to permit optimum adaptation to subjective picture impressions.

By combining the horizontal scaler 1, which can be adjusted in fine steps or steplessly by the fine decimation factor MHS/LHS, and the decimation filter 2, which can be adjusted by an integral decimation factor MHD, it follows that a total decimation factor MH is given by

MH = MHD * MHS/LHS = MHD * (1+(SHS/LHS)), MHD and SHS being adjustable. The number of pixels PD after the decimation is then yielded from the sampled pixels PS to PD = PS/MH. A large range of decimation factors can be adjusted by suitable combination of the factors for the two decimations. Thus, a gapless range of the total decimation factor from 2 to 12 can be adjusted by selecting 2, 3, 4, 6, and 8 as possible values for MHD and a fine decimation factor in the range of 1 to 1.5.

The use of multistep decimation filters which operate with several reduction factors is recommended for very large adjustable reduction factors. For the frequency response of the decimation filter set up for optimum image quality, the scaling means a change in the frequency axis, the form of the frequency response of the decimation filter being virtually retained, but the band limit moving ever further in the direction of the frequency 0. The targeted change in image size is thereby achieved virtually without loss of image quality.

In accordance with Figure 4, in principle the vertical decimation stage can be constructed in a way corresponding to the horizontal decimation stage.

Differences can arise from the mode of action of vertical filters, which require delays by a scanning line instead of delays by sampling periods.

In the case of line delay in the line delay device Z1, the pixels of a scanning line are stored and made available sequentially at the start of the next scanning line. The vertical scaler 3 calculates a new scanning line from the current and at least one delayed scanning line. The phase value is recalculated exactly once per line at the beginning. When it follows from the calculated phase value that the delayed line is not contributing to the new line, the output of this line is suppressed. Fractional rational decimation in the vertical direction is achieved in this way.

The quality of the vertical decimation filter 4 is chiefly limited by the number of available line delays in the line delay device Z2. Usually, sequential lines are simply accumulated in the case of only one time delay present. The vertical decimation stage can also undertake several line delays. In accordance with figure 4, the vertical decimation filter 4 also has a low-pass effect. The vertical total decimation factor is yielded as MV = MVD * MVS/LVS = MVD * (1+(SVS/LVS)), MVD and SVS being adjustable. The number of lines LD after decimation is then yielded from the sampled pixels LS as LD = LS/MV.

It is thereby possible to implement independent control of the vertical and horizontal decimation in a simple way and with a low outlay on hardware. Both the horizontal and the vertical decimation can be performed with non-integral values in a stepless or fine-step fashion. The fine-stepping of the scaling is possibly limited only by the resolution into whole pixels and lines. Optimum filtering, and thus a high image quality can be achieved with the aid of the low-pass filters and, if appropriate, peaking. The solution according to the invention can also be implemented in the case of

existing decimation filters by adding the scaler or scalers, or connecting them upstream.